Now we can look at where it all begins,
the primary organs of the immune system. Here is our drawing of a duck
with its bursa of Fabricius. This is the primary organ where bird
B cells rearrange their Ig genes. And this is the original
source of the term B cell. You can see it here as this
little pocket off the cloaca. But what about mammals? Here's the lymphatic system in green, and
we'll look at that again later in the next section when we look at
the secondary lymphoid system. But this does show you
where the thymus is, and I think you can probably also figure out,
more or less, where the bone marrow is. The bone marrow is the primary source
that produces most of the immune cells in your body. And here's a drawing of the
bone marrow. First, I'd like to point out the fat cells
in the middle of all the other cells, many of which are various
blood cell progenitors. A lot of the bone marrow is made out of
fat, and fossil bones from early human camp show that our ancestors
smashed open bones to get to it. You may tend to think of fat as being
some kind of, say, inactive storage cell, but the fat in the bone marrow is a cell
type that sends out a lot of signals that regulate hematopoiesis, or
that is the development of blood cells. This really does make sense because the
amount of fat you have will essentially signal your nutritional status, and
that will let the cells know just exactly how much energy they have to
put into the immune system. The bone marrow is the location
of the hematopoietic stem cells. They are few and far between, given their ability to regenerate and
then produce everything. And this is the site of
the production of both the myeloid and lymphoid cells, and of the lymphoid cells,
the B cells and NK cells. And the precursors of the T cells, which must migrate to the thymus before
they can finish their development. This picture is a stained
micrograph from the bone marrow. And just looking at it, you can see how
complicated the arrangement of cells is, and it looks like there
are a lot of different types. So again, this is where the B cells rearrange their
genes as part of their development. The T cells may start out here, but they
will rearrange their genes in the thymus. Most hematopoiesis occurs in
the bone marrow of the femur, which is your upper leg bone, the humerus,
your upper arm bone, the pelvis. And in fact,
if you're doing a bone marrow transplant, the donor is usually punctured
in the ilia of the pelvis. And the sternum, which I think is very
interesting because it turns out to be right next door to the thymus. The thymus is the region where
the T cells rearrange their genes. And here's some more pictures
to show you context. And we can see down here the blood vessels
actually enter the thymus, kind of in the mid range in between what we will see
later on is the cortex and the medulla. This section up here shows
a detailed of the thymus. And if we look at this and enlarge it,
we can see one of the lobules. Here is the thymic lobule. And you can see it looks like it's got
an outer region, which we call the cortex, and an inner region,
which we call the medulla. And those are just general terms for
outside and inside. They're not unique to the thymus. Here's an old classic
picture of the thymus. The T cells are going to
enter between the medulla and cortex in a relatively
undifferentiated state. They will then migrate outward and
rearrange the genes for their receptors. When they're done doing that,
they begin to go inwards and go through a very complex
selection process. The ones that survive,
and most of them don't, move back into the blood vessels
where the cortex and medulla meet. And then the cells will enter
the circulation there and move to defend the body. This is a very complex
process and we will look at it in detail in

the third unit of this course series. So what we've looked at are the three primary organs where genes are rearranged. We've seen the bursa of Fabricius in birds. We've looked at the bone marrow, where antibody genes rearrange, and finally, the thymus, where the T cells rearrange their receptors. And now it's time to move on to the lymph system and the secondary immune organs.